Integrating Programming Into Mathematics
Math 20 — Final Report

Planning Services

Alberta
EDUCATION

Alberta
EDUCATION

Devonian Building, West Tower, 11160 Jasper Avenue, Edmonton, Alberta, Canada T5K 0L2

July 8, 1985

To the Reader:

This study reports the evaluation of a 15 hour Computer Programming in Mathematics (CPM) elective developed and offered in the Math 20 course for two consecutive semesters by five teachers in a large Alberta senior high school.

The educational rationale for the elective is that computer programming in BASIC is in essence a mathematical activity. Once mastered, programming solutions to math concepts in BASIC will result in greater student understanding and achievement in mathematics.

Evaluative results of the initial offerings of the CPM elective seemed to show that it did not meet all of the objectives. However, the elective was viewed as challenging and beneficial by both students and teachers. The findings suggest that the CPM elective is a complex undertaking and one that may not be mastered by a teacher in the first and second offering. Subsequent offerings will likely result in improved student achievement and understanding of fundamental mathematical concepts. Teacher testimony to the worthiness of the elective is also cause for optimism.

Alberta Education is pleased to provide this copy of Integrating Programming into Mathematics 20. It should be of interest to teachers and other educational personnel who are looking for ways to bring computers into the senior high math curriculum.

Sincerely,

H. I. Hastings

H. I. Hastings
Director
Planning Services

INTEGRATING PROGRAMMING INTO MATHEMATICS

MATH 20

FINAL REPORT

Sol E. Sigurdson,
Research Consultant

D. Hunka,
Project Director

A project funded by
Alberta Education
and
Edmonton Public Schools

INTEGRATING PROGRAMMING INTO MATHEMATICS

TABLE OF CONTENTS

INTEGRATING PROGRAMMING INTO MATHEMATICS
MATH 20

Introduction

That computers have a role in mathematics education at any grade level is a given. Wanted are ways that have been worked out for teachers to use them. The elective component of the Math 20 course seemed an ideal way to bring computers into the senior high curriculum. Computers in education is a numbers game - in senior high school, the ratio can be 30 computers to 1400 students. Whatever the ratio, the problem of using computers effectively is a logistical one of assigning students to computers on a one-to-one basis. Apart from this, arises the question of the educational purpose to which computers will be applied. This ranges from problem solving to drill to literacy. Above these considerations is the need for valid instructional programs using computers that the classroom teacher can offer within the context of typical mathematics classrooms.

The current study sought to develop an elective unit in the Math 20 program which would teach students to program, in BASIC, solutions to typical Math 20 exercises. Logistically, the Math 20 class would be scheduled into the computer laboratory for one one-hour period per week. Many alternative approaches to computing in mathematics education are worthwhile. However, with students having computer contacts in other educational settings, programming in a strictly mathematical context seemed the most promising. With this background, the study focussed on three basic questions:

a. Could an instructionally-sound elective unit in Math 20 be developed?

b. In what ways could students benefit from this elective?

c. How did this elective complement the existing Math 20 course?

The Educational Rationale

Why programming when so many alternatives for computer use exist? Programming is an inherently mathematical activity. It deals with variables, functions, and numerical operations. When applied to Math 20 exercises, the activity is especially mathematical. If doing regular exercises in mathematics is practice in using mathematics concepts, then programming solutions to exercises can be thought of as high quality practice. Once the language of BASIC is "mastered," the student's focus is completely on the mathematical concept. Information-processing psychologists would argue that in a highly structured medium such as BASIC, the mathematical concepts can be dealt with more directly, resulting in greater understanding of the mathematics. Clearly this only happens if the student first becomes very familiar with the appropriate level of BASIC language, and secondly if the number of solutions programmed is adequate. Of relevant concern to this study is whether or not the elective can offer a substantial enough programming experience for this benefit to be realized.

Computer Programming in Mathematics(CPM)

The elective unit developed in this study is reported in a separate document- "Computer Programming in Mathematics."(*) The

*_______, Math 20, Alberta Education, 1984

development of the elective took place during two semesters in a large senior high school in Alberta which offered Math 20 on a semester timetable. During the first semester, teachers following a course plan taught the elective and met throughout the term to discuss modifications to the original outline. Semester two saw an agreed-upon course being followed by the five teachers. The main guidelines of the elective (presented in detail in the above mentioned document) are:

1. The elective is 15 hours in length.
2. The first five hours are devoted to learning the fundamentals of programming in BASIC.
3. The final ten hours has students programming solutions to typical Math 20 exercises.
4. For one hour per week of the Math 20 course, students are scheduled into the computer lab which contain 30 microcomputers.
5. Teachers offer the elective as an integral part of the Math 20 course with a view to achieving the goals listed below.

The elective as it was offered in the second term was monitored.

Educational goals of the elective

The educational rationale above gives the basic premise under which the elective was offered. Several other goals can be identified. The first four are directly related to the Math 20 course:

1. The student gains a better understanding of mathematical concepts.
2. The use of algorithms and algorithmic thinking are fostered.
3. Fundamental mathematical concepts such as variables, functions, and numerical operations gain new and deeper meaning.

4. Step-by-step, logical, analytical procedures, such as those employed in computer programming, become part of the student's repertoire of mathematical strategies.

The last two goals are more directly related to computers:

5. The student gains an understanding of the computer's role in mathematical activity.

6. The student learns about computers, how they function and, in particular, rudiments of the BASIC language.

Curriculum Evaluation - Design

The focus of the evaluation of any curriculum is on its prescribed goals, determining if students have benefited in predicted ways. While goal evaluation is the primary focus, evaluation of instructional processes is vital to any curriculum evaluation. Typical concerns in instructional process evaluation are the impact of the innovation (the elective) on the regular course (Math 20), teachers' reaction to the required classroom activities, the adequacy of physical facilities, and the appropriateness of instructional materials. The decision to implement any innovation (in this case, the elective) will hinge on the findings of both dimensions of curriculum evaluation.

The experimental setting

The curriculum development and the curriculum evaluation of the CPM elective took place in the first and second term respectively in a large Alberta senior high school. Five Math 20 teachers took part in the project. All five offered the elective in both terms. Evaluation in the second term took the form of a comparison to control groups of Math 20 students in four other senior high

schools in the same district. The problem of finding equivalent control groups is enormous since each school has its own standards for allowing students into Math 20. However because the numbers of students involved was large, the control groups were judged to be adequate for purposes of this comparison.

Goal evaluation and instruments

Ideally, goal evaluation attends to all goals of the program. The first four goals, relating directly to Math 20, are accounted for under two evaluation topics: achievement and understanding. The students' achievement and understanding scores should reflect the degree to which the Math 20 goals have been reached. The last two goals relating to computers were dealt with under three areas: computer awareness, attitude to computers, and knowledge of BASIC. Computer awareness looks at computer functioning, capabilities, applications, and societal impact. Attitude simply looks at the student's personal response, while knowledge of BASIC examines student's learning.

Achievement-

Achievement improvement could be affected by the realization of goals 1, 2, and/or 3. But equally important, the 15 hours spend on learning computer programming might have detracted from the usual achievement in Math 20. Both of these aspects of the achievement question can be accounted for by the typical year-end achievement test in Math 20.

Instrument- Math 20 Test

This test covers all aspects of the mathematics curriculum and a range of cognitive levels focussing on the fact, algorithmic, and problem solving levels. It covers all topics in the Math 20 program except the elective and is the usual measure of success in Math 20. The grading of this test was done by the teachers involved using their own scoring schemes for multiple choice and long answer. The total raw score on the test was 103 marks.

Understanding-

This dimension of the evaluation refers especially to goal one but also to goals 2, 3, and/or 4. Understanding in the context of Math 20 was seen as encompassing four aspects:

a. assumptions underlying procedures and formulas

b. analysis of parts of formulas

c. deeper insights into the role of variables, literal coefficients and functions

d. a capacity to deal with questions involving relationships between two or more concepts

Instrument- Understanding

This test(See Appendix A) consisted of 15 questions from topics in the Math 20 course and each relating to one of the above four dimensions of understanding in the following manner:

a. assumptions- 2, 11, 13

b. parts of formulas- 1, 7, 10, 15

c. role of variables, etc.- 5, 6, 8, 12, 14

d. relationships- 3, 4, 9

The grading of the test was based on three marks for each question.

Awareness of computers-

This dimension relates to both goals 4 and 5. The general questions of what computers are, how they are used, and what can we expect of them were asked. Though the CPM elective focussed rather directly on mathematics, application beyond mathematics were discussed formally and informally. The question here is how much benefit accrued in this area. Awareness was taken to encompass six dimensions:

a. the use of languages in communicating to computers

b. the operation of a microcomputer

c. the human element in computer usage

d. the use of computers in mathematical applications

e. the student's concerns about his future with computers

f. societal applications of computers

Instrument- <u>Computer Awareness</u>

The instrument(See Appendix B) consisted of twenty six items with which the student could rate a degree of agreement. The items related to the six dimensions accordingly:

a. language- 1, 12, 18, 20, 26

b. operation- 17, 19, 24, 25

c. human element- 13, 21, 22, 23

d. mathematics- 2, 9, 14, 15, 16

e. student concern- 3, 4, 5

f. society- 6, 7, 8, 10, 11,

Attitude to computers-

The focus was on the students' personal reaction to computers and relates tangentially to goal 5.

Instrument- Nyberg-Clarke Attitude Scale

Although this instrument(See Appendix C) was used to determine the attitude of students to school subjects, it can be applied to attitude toward any subject area, in this instance, computers. The scale is a semantic differential of 24 items, eight of which relate to each dimension of 1) liking the subject, 2) rating its usefulness, and finally 3) difficulty. Each item is given a score of one to five. Every student ends up with three attitude scores, one on each dimension.

Knowledge of BASIC-

In the CPM elective only the rudiments of BASIC were taught. The attempt was made to see if students had learned the language and some elements of simple programs. This relates directly to goal 5.

Instrument- Knowledge of BASIC

The instruments(See Appendix D) consists of 15 multiple choice items centering on the meaning of commands and correct usage of BASIC symbols within a program. Students were given a score of one for each item.

Instructional process evaluation design

Instructional process evaluation examines critically what it means to a teacher to offer this type of program. What thoughts and concerns do teachers have about the CPM program with regard to scheduling, facilities, finances, student motivation, and integration and interaction with the regular program? The researcher visited the five teachers involved in the program several times in their classrooms, interviewed them individually and met with the entire group several times. The instructional process evaluation report based on the data gathered was given to the teachers for their comments. In this way, all the observations have been double checked by the teachers.

Curriculum Evaluation - Analysis and Findings

Analysis

Simple t-tests and chi-square tests were used to compare the project group to the control group. All tests were deemed to be valid when viewed in the light of statistical analysis available for each administration of each instrument. The number of students in each comparison differs and is so stated. The mean for each test or sub-test is given for each group and the 2-tail probability of them being the same. In an exploratory, curriculum-evaluation study of this type, the .1 level of significance, indicated with an asterisk(*), is used. In most of the analyses in this study, we are interested in trends and indications rather than solid proof.

Goal Evaluation- Findings

Achievement

Hypothesis: The mean scores on the Math 20 Test are the same for both the project and control groups.

Analysis: t-test, significance level (.1).

	Project	Control	2-tail Probability
Number of students	133	128	
Total test mean	53	56	.11

Table 1. Math 20 Test - Mean raw score comparison - t-test

Interpretation - Although the difference in achievement is 3 points out of a total of 103, the difference is not significant. The project group did not score higher in achievement. That they did not score significantly lower is also worth noting. In terms of achievement the CPM elective has no affect.

Understanding

Hypothesis: For each of the 15 items on the Understanding Test the mean scores between the project and control groups will be the same.

Analysis: t-test, significance level (.1). Numbers per group as indicated in the Table 2.

Item No.	Project	Control	Significance at .1 level		
*1	1.7	2.5	C		
*2	2.3	1.3	P		
3	.6	.6			
				Project- 41	Control- 43
*4	2.5	1.8	P		
5	2.3	2.2			
6	1.5	1.2			
				Project- 47	Control- 48
7	1.9	1.9			
8	1.6	1.8			
*9	.9	1.4	C		
				Project- 46	Control- 55
*10	1.5	1.9	C		
*11	1.0	1.8	C		
12	1.7	1.6			
				Project- 32	Control- 60
13	1.7	1.9			
*14	.8	1.3	C		
15	.9	1.1			
				Project- 31	Control- 43

Table 2. Understanding Test - Mean score per item comparison - t-test. The numbers for each group are indicated after each three items.

Interpretation - Differences exist in 7 items. Five favour the control while only two favour the project. It is safe to conclude that the project group did not in general score higher on the understanding items. In fact, the opposite is suggested. The items favouring the control group do not fall into any one of the four dimensions of understanding. The seven items seem to follow a pattern related to mathematical topics. For example, the project group did better on both the trigonometry items while the control did better on over half of the quadratic items. This is surprising since many of the computer programming exercises were done on quadratics.

One possible interpretation of these results is that the

understanding items, besides measuring understanding, are highly content related. The project group did significantly better in trigonometry and the control in quadratics. But in any case, the results on understanding favour the control group.

Awareness of computers

Hypothesis: 1) For each of the 26 items, the patterns of responses will be the same for each group.

Analysis: 1) A chi-square test for 5 categories was done. The number of students in the project group is 72 and the control, 84. Significance (.1).

Item No.		Difference Indicated
6.	A computer can be programmed to write a play.	More "strongly disagree" from project group.
9.	It is fairly easy to write computer programs to solve math problems.	Fewer "neutral" responses in project group.
10.	Air Canada's computer terminal in Edmonton is is connected to a large central computer somewhere in Canada.	More "strongly agree" responses from project group.
13.	Computer mistakes are usually mistakes made by people.	More "agree" responses from project group.
14.	A computer is useful in solving problems that require creativeness in their solutions	More "strongly disagree" responses from the project group.
15.	A computer is especially useful for tasks that have to be repeated often.	More "strongly agree" responses from the project group.
16.	Computers are good at calculations that require speed, accuracy and repetitiveness.	More "strongly agree" responses from the project group.

Table 3. Computer Awareness - Items showing significant differences - chi square(.1)

Interpretation - For the remaining 19 items in the test no significant differences exist. Four of the 7 items showing

differences belong to the "mathematical applications" dimension of the awareness instrument. Interestingly, the project group did not think mathematics programs were easy to write, the main difference was that very few of the project group were undecided. The project group had a greater appreciation of the computer as "processor of numbers" than as a creative problem solver. Two other items indicating a difference belonged the "societal applications" dimensions. Here the project group believed more strongly that a computer cannot write a play and Air Canada has a large central computer. The final item showing a difference is the project group believing that most computer mistakes are people mistakes.

Hypothesis: 2) The mean total awareness score will be the same for each group.

Analysis: 2) After eliminating items 3,4,6,8, and 25; reversing items 5,12,14,17,21, and 23; and assigning a score of 1(strongly disagree) to 5(strongly agree); a mean total awareness score for each group was calculated. A t-test was used to compare the two groups. The numbers of students for the project and control group is 78 and 84.

	Project	Control	2-tail Probability
Number of students	78	84	
Mean total score	85.5	82.7	.03

Table 4. Computer Awareness - Mean total score t-test comparison

Interpretation- Considering all six aspects (dimensions) of computer awareness, the project group is "more aware" of computers than the control. Whether this greater awareness is educationally important is a debatable point. In any case, the control group does appear to know quite a bit about computers but as we have seen from Hypothesis 1) the main difference is not in direction

but in the strength of the conviction. In Item 6 for example, both group disagee that a computer can write a play but the project group <u>strongly</u> disagrees.

Attitude to computers

Hypothesis: For each of the three scales of the Nyberg-Clarke Attitude Scales, the mean score is the same both the project and control groups.

Analysis: A t-test was run for each scale separately.
Significance level (.1)
Evaluation- The higher numerical score indicates better liking.
Usefulness- The higher numerical score indicates perceived greater usefulness.
Difficulty- The higher numerical score indicates perceived less difficult.

	Project	Control	2-tail Probability
Number of students	72	84	
Evaluation	27.1	28.7	.12
*Usefulness	32.0	34.8	.00
Difficulty	19.3	20.0	.45

Table 5. Mean score of three scales of the Nyberg-Clarke Attitude Scales - t-test

Interpretation- Interestingly the control is more positive in every scale: like computers more, think they are more useful, and think they are easy. The only statistically significant difference, however, is usefulness. These findings might mean that the project group is less naively optimistic about computers, compared to the general positiveness about them in society. It could also mean that the CPM program has given students a bad feeling about computers.

Knowledge of BASIC

Hypothesis: The mean score on the Knowledge of BASIC Test will be the same for both project and control groups.

Analysis: A t-test was run on the mean total scores. Significance level (.1)

	Project	Control	2-tail Probability
Number of students	73	83	
*Mean Total Score	11.0	9.3	.00

Table 6. Mean total score on Knowledge of Basic Test - t-test.

Interpretation- Students in the project group score about 2 points higher out of a total of 15. The suggests that the average Math 20 class knows a considerable amount of BASIC but that the project group knows more.

Process Evaluation - Findings

The findings of the process evaluation are written into the curriculum and instruction guide of Computer Programming in Mathematics. (*)The reader is referred to this document for an elaboration of the findings. Below is given a short summary:

Elective

1. The CPM elective is a very challenging but rewarding program which most students feel is important.
2. Offering it at some time other than a regular mathematics period, such as noon-hour, has proven problematic.
3. Because of the potential of the computer for many and varied uses in mathematics education, the teacher is encouraged to stick closely to the proposed outline.

*_______, Math 20, Alberta Education, 1984

4. Since the benefit of the program is derived once BASIC is learned, the first five lessons must be taught thoroughly.

Students

1. Each Math 20 class contains 4 or 5 students with good computer backgrounds. They did not appear to pose a threat to any of the teachers. Teachers are encouraged to make effective use of them, probably as student helpers both in the classroom and the laboratory.

2. Enrichment activities for advanced students are readily available. Even students with Computing 20 (or similar course) find CPM beneficial.

3. Four or 5 students in any class need special help.

4. Class frustration levels peak during the fourth and fifth lessons when students begin to work seriously at entering and saving programs.

5. Although in general boys are more attracted to computer activity, girls do equally well in CPM.

Programming

1. The first programming assignments should be very explicit.

2. Students need to be encouraged to think programs through before coming to the lab period.

3. Teachers observe that students are consciously and purposefully working with mathematical concepts as they are writing their programs. This, as opposed to the often "rote" approach to the end-of-chapter exercises.

4. The quality of programs range from "bare-bones" to sophisticated. Programs should be written at a level where they can be looked at again after several weeks and easily used. The term "user-friendly" is used in this regard.

5. Students should be encouraged to use their programs to solve problems and to revise previously written programs.

Integration with the regular course

1. Computer programming concepts integrate directly into the regular mathematics lessons. Some examples are
   a. The BASIC command LET is used as a way of assigning variables in problem solutions.
   b. The step-by-step procedures of programming are used in writing up problem solutions.

c. Literal coefficients which are so prominent in computer programs take on a new status in classroom discussions.

2. Other concepts are indirectly applied
   a. The general concepts of variable and function are reinforced in programming.
   b. The notion of verifying a procedure, important in all mathematics is very explicit in programming.

Facilities

1. Having two or more types of computers in the computer lab adds greatly to the confusion and frustration of lab periods.

2. Teachers should have a computer for use during their preparation time.

Teachers

1. Teachers should know BASIC to the CPM level and be prepared to learn more.

2. Teachers must be completely familiar with the operation of the computer installation in the computer lab.

3. Teachers tended to offer the CPM elective differently, especially in such areas as teaching BASIC, assignment of problems, amount of guidance in programming, grading of programs, expectations on assignments, student-helpers, and carry-over to the regular program.

4. Teachers with a computing background tended to stress the programming component of the CPM elective more.

5. All teachers enjoyed offering the elective and found it stimulated their thinking about mathematics teaching.

Conclusions and Recommendations

Computer Programming in Mathematics- An Elective

The CPM elective as offered was viewed as a challenging program by both teachers and students. Students perceived the elective as an important component of the Math 20 course. Teachers saw the potential for the program to integrate well with the Math 20 course and thought that every student in their classes was

benefiting from the experience. Developing the elective in one semester and teaching it again in the second, the teachers in the project are planning to continue improving it and to consolidate it as a well-integrated part of the Math 20 experience.

As the process evaluation findings testify, offering the CPM elective is instructionally a complex undertaking and one that will not be mastered by a teacher in the first or second offering. Factors contributing to this complexity are

1. Teachers gaining some competence in computer programming.
2. The school having appropriate computer facilities which includes scheduling students one-to-one with a computer.
3. Tying the elective to the Math 20 course in a suitable fashion.
4. Accommodating the wide range of student capability in computing.
5. Having students efficiently achieving competence in programming, especially in view of the many other attractions the computer offers.
6. Offering an experience which is so clearly an "elective" to students in the midst of a demanding Math 20 course.

The initial development has been rewarding and indicates a bright future for the CPM elective.

Achievement and Understanding

The evidence here suggests that the CPM program detracted from the regular Math 20 course. If the control groups spent the 15 hours on matters more closely related to the Math 20 program, students would be expected to do better in achievement and understanding. While the differences are not great, we can safely say the gains in these areas do not come automatically with the CPM elective. However, it is expected that an improved offering of the CPM,

following this first attempt, will certainly close the gap. Teachers' testimony to the worthwhileness of the elective is also cause for optimism.

Computer-related Learnings

Even here the results do not overwhelmingly favour the elective. Students in regular Math 20 classes know a lot about computers.The CPM students have greater knowledge and awareness of computers but perhaps not to the degree one would expect. Interestingly, the CPM students' attitude to computers is clearly less optimistic (perhaps more realistic) especially in the usefulness dimension. Here, regular Math 20 students perceive computers to be more useful than the CPM students. This might be a consequence of CPM limiting computer experiences to programming. It could, in fact, mean that the typical Math 20 student has an overly optimistic view of the computer's usefulness.

Comment

Although the promise of the CPM elective has not been fulfilled in this particular project, perhaps our sights were initially too high. Should we realistically expect a 15-hour experience to produce measureable effects in level of understanding? Do we know the level of knowledge, awareness or the appropriate attitude for grade eleven students? Probably more important is that teachers and students "sense" that the activity is meaningful and relevant. As one teacher insisted, the CPM should <u>not</u> be an <u>elective</u> it should be part of the course. Math 20 should change to include this experience as an integral part of it. Mathematics courses

will change under the impact of computers. The CPM can serve as important groundwork for this exciting prospect.

Recommendations

1. The CPM elective should continue to be offered, improved, and monitored. Particular attention should be paid to

    a. a thorough grounding in rudimentary BASIC
    b. assigning exercises which involve important mathematics concepts from all topics
    c. using their programmed solutions to solve problems or to develop other programs
    d. integrating computer concepts and procedures into the Math 20 curriculum.

2. Teachers should be encouraged to use computers in various ways, outside of the elective, in senior high school mathematics.

3. Studies should be made to find ways of incorporating computers into the mathematics curriculum, especially for students with good computer backgrounds.

4. Studies should be undertaken to investigate classroom activities and testing devices related to the "understanding" dimension of mathematics learning.

5. Consultant and financial resources must be made available before any significant computer usage occurs in classrooms.

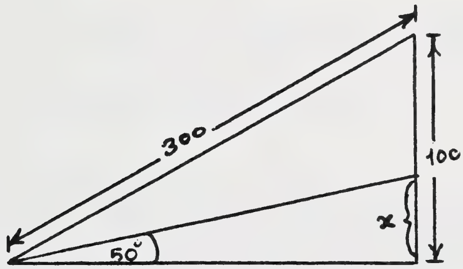
APPENDIX A

Understanding Test

These problems are the problems that were used in the Understanding Test.

1. $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ is the quadratic formula. How does the value of $b^2 - 4ac$ determine what type of roots the quadratic has?

2.



What do you have to assume to be true in order to find the value of x? Why is this assumption necessary? Describe how you would do it.

3. Given 3 points A(3,4) B(5,0) C(1,3), describe how you would find the slope of the line which is the altitude from A.

4. From the top of a cliff which has a height of A metres, a whale is signted by person 2 metres tall at an angle of depression of 20 degrees. How far out to sea is the whale? Do not answer the question.

   Draw a diagram.

   Which trigonometry function would you use to solve the problem?

5. $y = ax^2$

Does the graph of this function open upward or downward? How would you explain this to your classmate who doesn't believe it?

6. For the function $y = mx-b$, if x is increased by 1, how much change do we get in y? Is this an increase or a decrease? Why?

7. Given two equations $y = 2x^2$

$$y = 16x^2$$

Which equation is wider (fatter)? Why does the numerical coefficient make this difference?

8. Given 3 points (a,b) (c,d) (e,f). Describe how you would try to determine if they are all on the same straight line. <u>Do not</u> do the calculation.

9. Given two equations $2x + 3y = -1$

$$2x - 4y = 5$$

You are told to find the equation of a line which passes through the intersection of these two lines and whose slope is 5. Describe how you would do this.

<u>Do not</u> do the algebraic work of actually finding the equation.

10. $f(x) = (x-3)^2 - 5$

Why does $x = 3$ give you the smallest value of $f(x)$?

What value of x gives you the largest value of $f(x)$?

11. The slope of a straight line is constant. What can you say about the slope of a quadratic function?

12. The average height of players in a basketball team is 6 ft. A new player who is 7 ft. tall joins the team. What is the average height of the basketball team now? Describe how you would solve this problem.

13. Given the equation $ax^2 + bx + c = 0$, what are the value of x that make this equation equal to zero?

14. Given the equation $kx^2 - 5 = 0$

How do you find the value of k if you know 2 is a root?

<u>Do not</u> actually calculate the value of k.

15. Given 2 points (2,5) and (10,32) and the segment joining them. How would you find the coordinates of the point 1/3 of the way along the segment? Describe the method. <u>Do not</u> do the actual calculations.

APPENDIX B

COMPUTER AWARENESS

Instruction: There are no right or wrong answers. We want to know what YOU think.

DO NOT PUT YOUR NAME ON THE PAPER.

1. You have to know the language of a computer before you can tell it what to do........................SA A U D SD
2. If you know the rule for solving a mathematics exercise it is easy to do that exercise with a computer...SA A U D SD
3. I can see that I will eventually need to know more about computers..................................SA A U D SD
4. I enjoy playing video games...............................SA A U D SD
5. I am worried about the day when I will have to operate a computer......................................SA A U D SD
6. A computer can be programmed to write a play..........SA A U D SD
7. A computer could be programmed to control the temperature of a school throughout the day............SA A U D SD
8. Most families could use a computer to advantage in their homes...SA A U D SD
9. It is fairly easy to write computer programs to solve math problems......................................SA A U D SD
10. Air Canada computer terminal in Edmonton is connected to a large central computer somewhere in Canada...SA A U D SD
11. One computer can do the work of many people..........SA A U D SD

12. Computers can make up their own programs..............SA A U D SD

13. Computer mistakes are usually mistakes made by people...SA A U D SD

14. A computer is useful for solving problems that require creativeness in their solutions..........SA A U D SD

15. A computer is especially useful for tasks that have to be repeated often.........................SA A U D SD

16. Computers are good at calculations that require speed, accuracy and repetitiveness............SA A U D SD

17. The difference between a computer and an electronic typewriter is that a computer has a screen..SA A U D SD

18. The video game "pac-man" is the result of a person writing a program for a computer.............SA A U D SD

19. It is possible to program one computer to perform many different tasks..........................SA A U D SD

20. Any computer must be programmed before it can carry out specific tasks or operations............SA A U D SD

21. A computer can determine when someone has put in incorrect information..........................SA A U D SD

22. Information given to a computer must be completely free of errors..............................SA A U D SD

23. A computer quite often makes mistakes.................SA A U D SD

24. Special programs can be given to the computer through the disk and the disk drive..................SA A U D SD

25. A computer has a "brain" similar to a person.........SA A U D SD

26. Computers can only do what they are told to do........SA A U D SD

Nyberg-Clarke Attitude Scales

APPENDIX C

Subject Rated

Please place only one mark between each pair of words. Be sure not to leave out any of the pairs.

	very much	a bit	neither	a bit	very much	
nice	===	===	===	===	===	awful
boring	===	===	===	===	===	interesting
unpleasant	===	===	===	===	===	pleasant
dislike	===	===	===	===	===	like
bright	===	===	===	===	===	dull
dead	===	===	===	===	===	alive
lively	===	===	===	===	===	listless (inactive, lazy)
exciting	===	===	===	===	===	tiresome (makes a person feel tired)
useless	===	===	===	===	===	useful
important	===	===	===	===	===	unimportant
impractical	===	===	===	===	===	practical (useful or workable)
worthless	===	===	===	===	===	valuable
helpful	===	===	===	===	===	unhelpful
unnecessary	===	===	===	===	===	necessary
harmful	===	===	===	===	===	advantageous (brings good or gain)
meaningful	===	===	===	===	===	meaningless (doesn't make sense)
hard	===	===	===	===	===	easy
light	===	===	===	===	===	heavy (a lot of work)
clear	===	===	===	===	===	confusing (mixes a person up)
complicated	===	===	===	===	===	simple
elementary	===	===	===	===	===	advanced (beyond the beginning level)
strange	===	===	===	===	===	familiar
understandable	===	===	===	===	===	puzzling (hard to understand)
undemanding	===	===	===	===	===	rigorous (has to be exactly right)

APPENDIX D

Knowledge of BASIC

Instruction: Please circle only one correct answer for each question.

1. What command should you type in order to clear the computer memory?

   a. LIST b. NEW c. DEL d. HOME (or CLR)

2. Why do you have to press the RETURN key after each statement or command is typed?

   a. To transmit the typed statement or command to the computer memory.

   b. It's the easiest way to have the cursor appear on the left hand side of the screen.

   c. Like a typewriter you can only type one line at a time.

   d. None of the above.

3. What is the different between LIST and RUN?

   a. LIST displays a program, but RUN executes a program.

   b. LIST executes a program, but RUN displays a program.

   c. Both display a program.

   d. Both execute a program.

4. What is the right statement about REM?

   a. REM stands for remark.

   b. A REM statement provides a means of identification for the program.

   c. It does not effect the running of the program.

   d. All of the above.

5. What command should be used to retrieve a program from a disk?

   a. CATALOG b. RECALL

   c. LOAD (or DLOAD) d. SAVE (or DSAVE)

6. What command should be used to show what programs are on a disk?

   a. LIST b. LOAD (or DLOAD)

   c. CATALOG d. SAVE (or DSAVE)

7. Which statement is true about a computer program?

   a. A program is series of instructions.

   b. Each statement needs a line number.

   c. It is executed from the lowest line number.

   d. All of the above.

8. Which operation has the correct notation in BASIC for $\frac{(4\times5)\div2}{10\frac{1}{2}\times8}$

   a. ((4*5)/2)/(10*.5*8) b. ((4*5)/2)/(10.5*8)

   c. (4*5)/(2/10.5)*8 d. (4*5)/(2/10*1/2*8)

9. Which sentence is <u>not</u> true for the numeric variable?

   a. The first letter must always be alphabetic.

   b. May be represented by two letters.

   c. May be represented by a letter followed by a single digit.

   d. Must be typed within quotation marks.

10. Let A=2 and B=3. Which pair have the same output in BASIC?

   a. A*B and AB b. A*B and (A)(B)

   c. A*B and (A)*(B) d. AB and (A)(B)

11. Which program contains <u>no</u> error(s)?

a.
```
10 PRINT 6(3+2)
20 END
```

b.
```
10 LET A8 = 6
20 PRINT A8
30 END
```

c.
```
10 LET X = 7
20 LET Y = A*X
30 PRINT Y
40 END
```

d.
```
10 INPUT A
20 LET B = 2+A
30 PRINT B = 2+A
40 END
```

12. Which line of the following program contains error(s)?

```
10 INPUT A
20 LET A+1 = B
30 PRINT B*A
40 END
```

a. line 20   b. line 20 and 30

c. line 30   d. no error line(s)

13. What is the result of running the following program?

```
10 PRINT"A+B = "
20 END
```

a. A+B = A+B   b. A+B = 0

c. A+B = A (or B)   d. A+B =

14. If you run the following program on a computer, what will be the output?

```
10 LET A = 10
20 LET B = 15
30 IF A>B THEN 70
40 LET A = A+10
50 LET B = B+2
60 IF A>=B THEN 80
70 PRINT  A
80 PRINT B
90 END
```

a. 17   b. 20   c. 20   d. 10
                   17   15

15. What will be the output of the program on the right hand side?

```
10 LET N = 1
20 PRINT N;
30 IF N = 13 THEN 60
40 LET N = N+2
50 GOTO 20
60 END
```

a. 1   b. 1 3 5 7 9 11 13

c. 1 13   d. 1 2 3 4 5 6 7 8 9 10 11 12 13